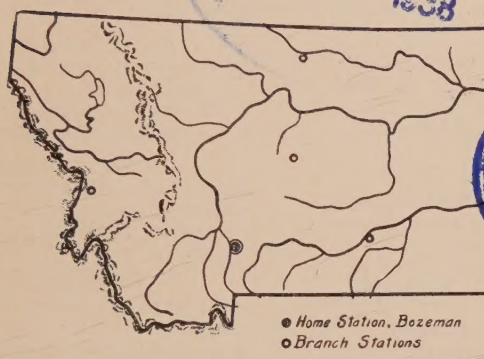
EXPERIMENTAL PROJECTS

Montana Agricultural Experiment Station



9 1938
IMPERIAL MYCOLOGICAL INSTITUTE
29 DEC. 1938

THIRTY-NINTH ANNUAL REPORT

July 1, 1931, to June 30, 1932

F. B. LINFIELD, DIRECTOR

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

ORGANIZATION OF THE EXPERIMENT STATION

MELVIN A. BRANNON Ph. D., Chancellor ..... Helena
ALFRED ATKINSON, D. Sc., President ..... Bozeman
F. B. LINFIELD, B. S. A., Director ..... Bozeman

AGRICULTURAL ECONOMICS

M. L. WILSON, M. S., Head of Dept.
*E. A. STARCH, B. S., Assoc. Agr. Econ.
R. R. RENNE, Ph. D., Asst. Agr. Econ.
P. L. SLAGSVOLD, Ph. D., Asst. Agr. Econ.
M. H. SAUNDERSON, A. M., Stat. Res. Asst.

AGRICULTURAL ENGINEERING

H. E. MURDOCK, M. E., C. E., Head of Dept.
O. W. MONSON, M. S., Asst. Agr. Engin.

AGRONOMY

CLYDE McKEE, M. S., Head of Dept.
L. F. GIESEKER, M. S., Assoc. Agron. (In charge Soil Survey)
A. H. POST, M. S., Assoc. Agron.
WILLIAM DeYOUNG, A. M., Asst. Agron. (Soil Survey)
A. G. GOTH, M. S., Asst. Agron.
L. P. REITZ, B. S., Assistant.

ANIMAL HUSBANDRY

LOUIS VINKE, M. S., Head of Dept.
W. F. DICKSON, M. S., Asst. An. Husb.
FRANK BARNUM, B. S., Assistant

BOTANY AND BACTERIOLOGY

H. E. MORRIS, M. S., Head of Dept.
P. A. YOUNG, Ph. D., Asst. Bot. and Bact.

CHEMISTRY AND METEOROLOGY

EDMUND BURKE, B. S., Head of Dept. and Meteorologist
W. M. MARTIN, Ph. D., Assoc. Chem.
J. R. GREEN, B. S., Asst. Chem.
IVER J. NYGARD, M. S., Assistant
CYRIL EVANS, Assistant

ENTOMOLOGY

A. L. STRAND, Ph. D., Head of Dept. and State Entomologist
G. ALLEN MAIL, M. S., Asst. Ent.
R. E. WALL, Ph. D., Asst. Ent.

GRAIN LABORATORY

W. O. WHITCOMB, M. S., Superintendent
W. D. HAY, B. S., Seed Analyst
D. M. FEESE, Assistant

HOME ECONOMICS

JESSIE E. RICHARDSON, Ph. D., Head of Dept.
HELEN L. MAYFIELD, M. S., Assistant

HORTICULTURE

F. M. HARRINGTON, M. S., Head of Dept.
C. C. STARRING, M. S., Assoc. Hort.

VETERINARY RESEARCH LABORATORY

HADLEIGH MARSH, B. S., D. V. M., Head of Dept.
HOWARD WELCH, B. S., D. V. M., Veterinarian
E. A. TUNNICLIFF, D. V. M., M. S., Asst. Vet.
T. T. CHADDOCK, B. S., Assistant

JOHN DEXTER, B. S., Agricultural Publicity
I. E. BROADDUS, Station Clerk
MARY L. HASKINS, Publication Clerk

BRANCH STATIONS

HORTICULTURE (CORVALLIS)

W. E. POLLINGER, Superintendent

HUNTLEY (HUNTLEY)

DAN HANSEN, Superintendent**
A. E. SEAMANS, B. S., Dry Farming**
D. V. KOPLAND, B. S., Dairying**

JUDITH BASIN (MOCCASIN)

J. E. NORTON, M. S., Superintendent**
J. L. SUTHERLAND, M. S., Cereals**
H. E. TOWER, B. S., Forage Crops**

NORTHERN MONTANA (HAVRE)

G. W. MORGAN, B. S., Superintendent**
M. A. BELL, M. S., Asst. Agronomist**

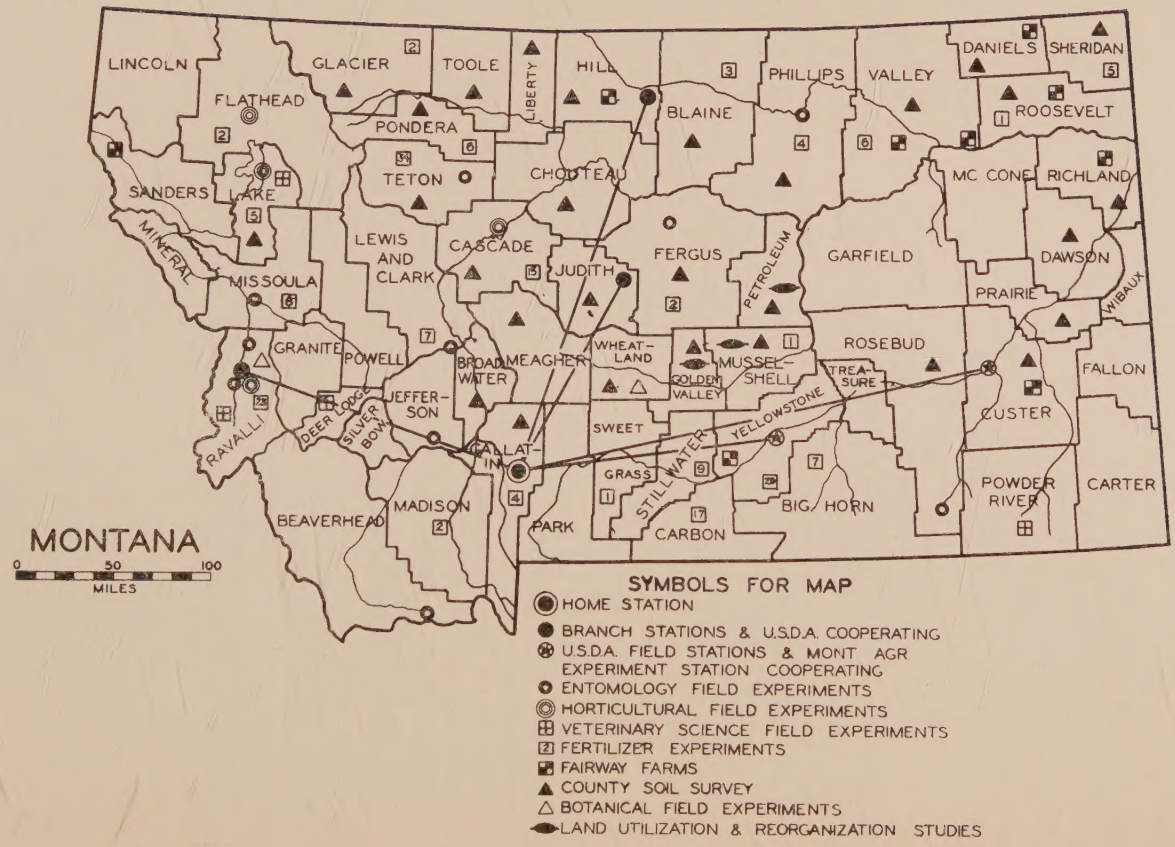
U. S. RANGE LIVESTOCK (MILES CITY)

J. R. QUESENBERRY, M. S., Supt.**
A. L. BAKER, B. S., Beef Cattle**
R. E. HUTTON, B. S., Swine**
J. M. COOPER, B. S., Sheep**
E. B. OSBORN, B. S. A., D. V. M., Horses**
S. J. MARSDEN, B. S., Poultry**

Note—Organization as of November 30, 1932.
*On leave of absence.
**Cooperating with the United States Department of Agriculture.

CONTENTS

	Page
Productive and economic problems of Montana agriculture	5
Active experimental projects	8
Agronomy	8
Agricultural Economics	9
Agricultural Engineering	10
Animal Husbandry	10
Botany and Bacteriology	12
Chemistry	12
Entomology	13
Home Economics	14
Horticulture	14
Veterinary Research Laboratory	15
Montana Grain Inspection Laboratory	15
Soil Surveys	16
Horticultural Branch Station	17
Judith Basin Branch Station	17
Northern Montana Branch Station	21
Huntley Field Station	25
United States Range Livestock Experiment Station	26
The station staff	29
Buildings and equipment	29
Cooperation with other agencies	29
Publications	29
Meteorological report for 1932	31
Financial summary	32


LINCOLN
GLACIER
TOOLE
LIBERTY
HILL
PHILLIPS
VALLEY
DANIELS
SHERIDAN
FLATHEAD
PONDERA
BLAINE
ROOSEVELT
SANDERS
LAKE
TETON
CHOUTEAU
MC CONE
RICHLAND
MINERAL
LEWIS AND CLARK
CASCADE
JUDITH
FERGUS
PETROLEUM
GARFIELD
DAWSON
MISSOULA
PRAIRIE
WIBAUX
GRANITE
POWELL
BROADWATER
MEAGHER
WHEATLAND
GOLDEN VALLEY
MUSSELSHELL
ROSEBUD
TREASURE
FALLON
RAVALLI
DEER LODGE
SILVER BOW
JEFFERSON
SWEET
CUSTER
GALLATIN
YELLOWSTONE
STILLWATER
GRASS
BIG HORN
POWDER RIVER
CARTER
BEAVERHEAD
MADISON
PARK
CARBON
MONTANA
0 50 100
MILES
SYMBOLS FOR MAP
HOME STATION
BRANCH STATIONS & U.S.D.A. COOPERATING
U.S.D.A. FIELD STATIONS & MONT AGR EXPERIMENT STATION COOPERATING
ENTOMOLOGY FIELD EXPERIMENTS
HORTICULTURAL FIELD EXPERIMENTS
VETERINARY SCIENCE FIELD EXPERIMENTS
FERTILIZER EXPERIMENTS
FAIRWAY FARMS
COUNTY SOIL SURVEY
BOTANICAL FIELD EXPERIMENTS
LAND UTILIZATION & REORGANIZATION STUDIES

EXPERIMENTAL PROJECTS

PRODUCTIVE AND ECONOMIC PROBLEMS OF MONTANA AGRICULTURE

The Montana Agricultural Experiment Station, established by the state legislature in 1893, was located adjoining the city of Bozeman. About a half section of irrigated land makes up the farm where the experimental grain and forage crops, fruits, and vegetables are grown, and where the hay meadows and pastures for livestock are provided. This irrigated farm land affords opportunity to study the problems of the irrigated areas in the higher valleys of the state. The soil is an old alluvial silt loam, bordering on the heavy side, with small areas of silty clay. The soil is from three to five feet in depth and overlies a gravelly subsoil.

About three miles east of the college is about 550 acres of non-irrigated land known as the Fort Ellis farm, which is used to maintain an experimental flock of sheep. Mountain pasture for these sheep is provided during the summer through a cooperative arrangement with the United States Forestry Service. The soil of this farm is a deep silt loam with some gravel intermixed in the lower levels. It is an old lake-bed deposit.

The climate of the Gallatin Valley is typically northern but with less extremes than in the plains area farther east. The length of the growing season, or the period between the last killing frost in the spring and the first in the fall, is about 122 days, varying from 100 to 149 days through the years. The altitude at Bozeman is about 4,800 feet above sea level. The valley (Gallatin) is surrounded by mountains, some to the north rising to 10,000 and 11,000 feet above sea level.

An attempt to picture the service of the Agricultural Experiment Station to the various regions of the state is presented on the opposite page. In this report are listed the projects carried on by the several departments located at Bozeman and by the various branch stations where definite and long continued studies are being carried on. Attention is also called to the fact that many special phases of the farm problems are being studied and that these cover a wide field of scientific inquiry.

It is fully recognized that agriculture is an art, an occupation, a means of making a living, and that down through the ages since

man first cultivated the soil succeeding generations of farmers have added to his experiences and have worked out empirically many successful agricultural methods. Scientific investigation has demonstrated the soundness of many of these practices and in many instances has added explanations of the results and indicated dependable methods of control and modification. However, scientific research and invention have done more than this and in the past one hundred years have modified and improved agricultural practices much more than in the preceding two thousand years.

With the progress of civilization and the increase in its complexity the problems of the farm have also multiplied and broadened. To quantity of product has been added quality as a large factor in price, while economy and efficiency of production and marketing are now large factors in determining the farmer's income.

Modern transportation, business, and finance have brought to our markets agricultural products from the borders of the nation and from the ends of the earth. Only those farmers who can compete in this nation-wide, world-wide market for the world crops, will be able to survive, while the measure of their income will be largely determined by the economy of their production and the quality of the product. The ability of the farmers in any locality to hold their own under present conditions will measurably depend on their ability, individually and collectively, to bring to their aid all that science, engineering, and efficient organization have to offer.

It was to assist in bringing this aid that agricultural experiment stations were established and their work enlarged as the years passed. They have employed men, thoroughly trained and experienced, to work on these problems and have provided them with laboratories and equipment adequate for the tasks assigned. Members of the staff are encouraged to visit all parts of the state to study local problems. As far as possible, they are aided in visiting scientific workers and laboratories in other states where similar or related problems are being studied under somewhat different conditions. Such conferences are helpful because agricultural research wherever carried on may illumine the scientific principles underlying the problems under study. For the same purpose, libraries are established and maintained, thus making available to all station workers the latest experiences and scientific facts bearing on any particular problem. The findings of

the Montana Agricultural Experiment Station, as published in bulletins and technical periodicals, are asked for by every civilized country of the world which in exchange send many of their agricultural reports and bulletins to our library.

Montana is a large state, as large as Sweden, three times as large as England, and considerably larger than all the British Isles. It is three-fourths the area of France or Germany. Compared with the other states, the area of Montana is about four times that of Ohio or Indiana, nearly three times that of Wisconsin or Illinois, and about twice the area of North Dakota, Minnesota, or Kansas.

The farming areas of Montana range from 2,000 to nearly 6,000 feet above the sea level and from a plains area in the east to high mountain valleys in the west. Precipitation ranges from 10 to over 20 inches, with an average of close to 14 inches, varying of course with the years. Some 2,000,000 acres of land in the state are under irrigation while projects have been proposed that will more than double this area. From 12,000,000 to 15,000,000 acres may, under average conditions, be farmed successfully by dry farming methods and the remainder of the state, some 70,000,000 acres, is range pasture, mountains, and forest. These facts give some idea of the great variations in the agricultural possibilities and agricultural uses of different parts of the state.

To determine the best use of this large area with its great diversity is the agricultural problem of Montana. To a very large extent the future progress of the state is dependent on the wisest and fullest use of this vast and varied agricultural resource. The Agricultural Experiment Station is the agency the state has set up to work out plans for the more efficient utilization of this area. This report lists the specific problems on which the station is at present engaged. These may be enlarged, modified or added to as conditions and demands make necessary.

ACTIVE EXPERIMENTAL PROJECTS

DEPARTMENT OF AGRONOMY

Biochemical studies of factors affecting the quality of wheat and flour for milling and baking. Cooperative with Chemistry. (Adams Fund)

Wheat breeding to produce larger yielding and better quality varieties, more suitable to the irrigated lands of the higher valleys of Montana. (Purnell Fund)

Improvement of varieties of seed and canning peas, with a study of some of the genetic problems involved. (Purnell Fund)

Date of seeding and method of treatment to control smut in wheat. Cooperative with Botany and Bacteriology. (Purnell Fund)

Influence of crop sequence upon the protein content and yield of wheat. Coooperative with Chemistry. (Purnell Fund)

Influence of tillage methods upon the protein content and yield of wheat. Cooperative with Chemistry. (Purnell Fund)

Breeding Great Northern beans for disease resistance. Cooperative with Botany and Bacteriology. (Purnell Fund)

Effect of calcium chlorate and other chemicals in controlling perennial weeds. (Purnell Fund)

Breeding smut-resistant varieties of wheat of high quality and superior yield. From 1,000 to 1,500 varieties and crosses are being used in this test. (Hatch and State Funds)

A study of the principles of wheat breeding by observing the results from many direct and reciprocal crosses. Some 500 to 600 crosses are being studied. (Hatch and State Funds)

Certain phases of the grain breeding and variety testing are in cooperation with the Bureau of Plant Industry, United States Department of Agriculture. A large number of crosses and new varieties are provided by the department and some funds are made available to carry on the studies. (Hatch and State Funds)

Variety tests with cereal and other grains under irrigation on about 300 to 350 one-fiftieth-acre plots and 3,500 rod rows. (Hatch and State Funds)

(a) Winter wheat—98 varieties and crosses
(b) Spring wheat—180 varieties and crosses
(c) Oats—82 varieties and crosses

(d) Barley—48 varieties and crosses
(e) Rye—4 varieties
(f) Flax—37 varieties and crosses
(g) Peas—4 varieties

Alfalfa studies under irrigation in the Gallatin Valley on 60 one-fiftieth-acre plots. (Hatch and State Funds)

(a) Studies with 15 varieties of alfalfa
(b) Studies in seed production

Nursery studies with small grains and forage crops. (Hatch and State Funds)

(a) Winter-hardiness nursery
(b) Miscellaneous crop and demonstration nursery
(c) Cooperative nursery tests with farmers to compare results with cereals grown in different parts of the state.

Irrigated crop rotations—48 rotations and 96 plots. (Hatch and State Funds)

Production of foundation seed stock of the standard varieties of small grains and flax for distribution to Montana farmers. (Hatch and State Funds)

Miscellaneous tests with fertilizers, with the effect of smut on grain yields, with bean varieties, and with sunflowers. (Hatch and State Funds)

DEPARTMENT OF AGRICULTURAL ECONOMICS

Range sheep production in Montana—economic aspects of ranch organization and operation. (Purnell Fund)

Range cattle production in Montana—economic aspects of ranch organization and operating practice. (Purnell Fund)

Experimental tests of farm organization for areas in Montana which have shown maladjustment. (Purnell Fund)

Requirements and organization of land, labor, and capital on mechanized wheat farms in Montana. (Purnell Fund)

Economic analyses of the marketing of Montana livestock. (Purnell Fund)

Study of present economic status and patterns of land utilization, together with possibilities for readjustment in organization and use of land. (Purnell Fund)

Montana farm taxes—an analysis of farm tax problems and plans for possible improvement. (Purnell Fund)

Management problems of farmers' elevators in Montana. (Hatch and State Funds)

Historical analyses of Montana prices for major agricultural projects. (Hatch and State Funds)

Farm taxation in the Gallatin Valley—an analysis of tax problems and plans for possible improvement. (Hatch and State Funds)

DEPARTMENT OF AGRICULTURAL ENGINEERING

The efficient use of tractors in farming operations on a two-tractor type of mechanically operated wheat farm. (Purnell Fund)

More effective and economical summer fallowing with implements available or to be devised. (Purnell Fund)

Control of flood waters on agricultural lands to prevent soil erosion, conserve flood waters, and increase soil moisture. (Purnell Fund)

The effect of precipitation of varying intensities and duration on the amount of run-off and its soil-eroding power on agricultural lands. (Purnell Fund)

The economy, effectiveness, and adaptability of different methods of irrigation for field crops in Montana. (Purnell Fund)

Methods and advantages of the treatment of fence posts and other farm timbers with various preservatives. (Hatch and State Funds)

The improvement of irrigation practice and the possibilities of individual farm irrigation by the construction of small dams and diversion irrigation systems. (Hatch and State Funds)

Prevention of losses by seepage from irrigation canals and ditches. (Hatch and State Funds)

Comparative crop returns on lands below the ditch from irrigation and from dry-farming practices. (Hatch and State Funds)

DEPARTMENT OF ANIMAL HUSBANDRY

Influence of barley and of oats on the quality and palatability of lamb. (Purnell Fund)

The effects of planes of nutrition of range ewes on lamb and wool production. (Purnell Fund)

Inheritance of size, form, and productive capacity of range ewes. (Purnell Fund)

Relation of type to production of range beef cattle. (Purnell Fund)

Heredity as a factor in determining twinning in Rambouillet sheep. (Purnell Fund)

Feeding the dairy cow—the best feeds and methods of feeding to get maximum yields of milk on an economical basis. (Hatch and State Funds)

Hull barley compared with hull-less barley and frosted wheat, each with tankage, for fattening spring pigs in a dry lot. (Hatch and State Funds)

Hull barley compared with blue hull-less barley, each with tankage as 8 per cent of the total concentrates, for fattening spring pigs on alfalfa pasture. (Hatch and State Funds)

Bone meal and potassium iodide with barley and alfalfa hay for fattening pigs. (Hatch and State Funds)

Results of feeding growing pigs on alfalfa pasture with 1½ pounds of barley per head daily—with no supplements, with tankage comprising 4 per cent of the grain ration, and with tankage comprising 8 per cent of the grain ration. (Hatch and State Funds)

Hogging down field peas as an economical method of harvesting. (Hatch and State Funds)

A comparison of low-protein wheat and hull barley when forming the whole ration and when fed in limited rations, with tankage, to pigs on alfalfa pasture. (Hatch and State Funds)

Value of bone meal for spring pigs with a limited ration of hull barley and with a limited ration of hull barley and tankage, both on alfalfa pasture. (Hatch and State Funds)

Value of cull peas in fattening pigs and the effect of the peas on the hardness of the pork. (Hatch and State Funds)

The economics in feeding low-priced wheat to livestock compared with selling the wheat at market price. Cooperative with Agricultural Economics. (Hatch and State Funds)

Feeding beet by-products to lambs to determine the most practical rations when fed with alfalfa and grain of various kinds. (Hatch and State Funds)

Relation of age, weight and wool production, body conformation, and methods of feeding to lamb production with range ewes. (Hatch and State Funds)

Methods of utilizing grazing lands with range sheep to prevent deterioration of the range and to build up carrying capacity. (Hatch and State Funds)

Comparative value of cottonseed cake and molasses, fed singly and in combination with a wheat and alfalfa hay ration for fattening lambs. (Hatch and State Funds)

Value of dried molasses beet pulp as a feed for breeding ewes. (Hatch and State Funds)

Fattening calves with Montana-grown grains and alfalfa, with and without supplements. (Hatch and State Funds)

DEPARTMENT OF BOTANY AND BACTERIOLOGY

Degeneration diseases of potatoes—their nature and control. Cooperative with Horticulture. (Adams Fund)

Bacterial blight and root rots of cultivated peas. (Adams Fund)

Bacterial blight and mosaic disease of cultivated beans. (Adams Fund)

Oil sprays—their effect on plants, especially apple. Cooperative with Chemistry and Entomology. (Purnell Fund)

The influence of plant foods upon the chemical composition, growth, and general physiological condition of the apple tree. Cooperative with Chemistry and Horticulture. (Purnell Fund)

Date of seeding and methods of treating wheat to control smut. Cooperative with Agronomy. (Purnell Fund)

Breeding Great Northern beans for varieties resistant to blight, rust, and mosaic. Cooperative with Agronomy. (Purnell Fund)

Uniform rust nursery to study prevalence of black stem rust on different varieties of oats and wheat. Cooperative with United States Department of Agriculture. (Hatch and State Funds)

Study of plant succession on range lands that have been broken, cultivated, and cropped from three to eight years. Cooperative with Entomology. (Hatch and State Funds)

Barberry eradication in relation to the prevention of black stem rust of wheat. Cooperative with United States Department of Agriculture. (Hatch and State Funds)

DEPARTMENT OF CHEMISTRY

Biochemical studies of factors affecting the quality of wheat and flour for milling and baking. Cooperative with Agronomy. (Adams Fund)

Oil emulsions and oil sprays. Cooperative with Botany and Entomology. (Purnell Fund)

The effect of phosphate fertilizer on the yield and phosphate content of forage plants. (Purnell Fund)

The influence of plant foods upon the chemical composition, growth, and general physiological condition of the apple tree. Cooperative with Botany and Horticulture. (Purnell Fund)

Influence of crop sequence upon the protein content and yield of wheat. Cooperative with Agronomy. (Purnell Fund)

Influence of tillage upon the protein content and yield of wheat. Cooperative with Agronomy. (Purnell Fund)

Studies of infertile soils due to alkali and other chemicals or to bad physical conditions. (Hatch and State Funds)

Meteorological observations at Bozeman. (Hatch and State Funds)

Study of soils to determine the natural fertility of different types of soil. Cooperative with Soil Survey. (Hatch and State Funds)

Effect of phosphate fertilizers on different types of soil over the state, both irrigated and non-irrigated, with such crops as cereal grains, alfalfa, sugar beets, potatoes, and peas. (Hatch and State Funds)

DEPARTMENT OF ENTOMOLOGY

Toxicity of insecticides and their effectiveness in control of insects. (Adams Fund)

Cutworms—life history, habits, control, and distribution. (Adams Fund)

Wheat leaf beetle—life history, distribution, and control. (Adams Fund)

Insect relation to virus diseases of plants, with special reference to bean mosaic. (Adams Fund)

Oil sprays—their effect on insect life at various stages of development. Cooperative with Botany and Chemistry. (Purnell Fund)

Mosquitoes—life history and control. (Purnell Fund)

Insects on abandoned land and their relationship to injury done to adjoining crops. (Purnell Fund)

Control of leaf cutter bee on shelterbelt plantings. (Purnell Fund)

Insect survey of Montana to note each year what insects are damaging crops. (Hatch and State Funds)

Forecasting insect outbreaks, by studying through the years the increase in the numbers of insects in various localities and the conditions that favor such increases. (Hatch and State Funds)

The relation of temperature, both of the soil and of the air, to insect survival. (Hatch and State Funds)

DEPARTMENT OF HOME ECONOMICS

Effect of winter storage on the cooking qualities and palatability of vegetables. (Purnell Fund)

Effect of winter storage on the vitamin content of vegetables. (Purnell Fund)

Effect of various grains on the quality and palatability of lamb. (Purnell Fund)

Selection, care, and wearing qualities of women's hosiery. (Purnell Fund)

Canning of green peas at high altitudes. (Purnell Fund)

DEPARTMENT OF HORTICULTURE

Degeneration diseases of potatoes—their nature and control. Cooperative with Botany. (Adams Fund)

Factors which modify the type, shape, and grade of potatoes. (Purnell Fund)

Factors influencing the maturing of potatoes. (Purnell Fund)

The influence of plant foods upon the chemical composition, growth, fruiting, and general physiological condition of the apple tree. Cooperative with Botany and Chemistry. (Purnell Fund)

Relative value of growing vegetable transplants which are started in greenhouse, hotbed, or cold frame. (Purnell Fund)

Small fruits—varieties and cultural practices best adapted to various parts of the state. (Hatch and State Funds)

Vegetables—varieties and methods of growing which contribute to yield, quality, and earliness. (Hatch and State Funds)

Trees and shrubs—their hardiness and suitability for use as ornamentals and for shelterbelts and windbreaks. (Hatch and State Funds)

Hardiness of tree fruits and their suitability for the home orchard in Montana. (Hatch and State Funds)

Onions—best methods of growing in Montana. (Hatch and State Funds)

Premature seeding of celery—cause and prevention. (Hatch and State Funds)

VETERINARY RESEARCH LABORATORY

The department of Veterinary Science was organized in 1893. The work was discontinued in 1896 but was resumed in 1909 when the building that had been erected for the dairy department was rearranged for the veterinary work. In 1929, through cooperation with the State Livestock Sanitary Board, the department was enlarged and reorganized as the Veterinary Research Laboratory. The following projects are now being studied.

Progressive pneumonia in sheep—its nature and control. (Adams Fund)

"Stiffness" in lambs, associated with white areas in muscles. (Adams Fund)

Big-head in sheep—its cause and control. (Adams Fund)

Vibrionic abortion in sheep—source of infection and development of immunity. (Adams Fund)

Causes of loss of lambs at lambing time. (Purnell Fund)

Coccidiosis in cattle—sources of infection and methods of treatment. (Purnell Fund)

Lamb dysentery—the cause, and methods of prevention or cure. (Purnell Fund)

Foot-rot in sheep—source and control of infection. (Purnell Fund)

THE MONTANA GRAIN INSPECTION LABORATORY

This laboratory was established by the state legislature in 1913 to provide definite information for the farmers of the state on the purity and germination of seeds and on the grades of grain. Later provision was made for testing wheat for protein content. The laboratory has been fully equipped for the following service:

Purity and germination tests of farm seeds, including grasses, alfalfa, clover, etc.

Inspection and grading of grain, both on samples sent to the laboratory and on cars of grain in local railroad yards and at mills. The men doing this work are licensed by the United States Department of Agriculture.

Inspection of seeds of all kinds offered for sale in the state, followed by tests of their quality in the laboratory.

Analyses of Montana wheats to determine protein content for farmers and dealers. This is an important factor in marketing.

Milling and baking tests of Montana wheat to determine the relative value of varieties and of wheat grown under different conditions.

Out of these service projects has come the need for considerable research to improve methods of carrying on the work of the laboratory, including the relation of the length of time and the storage conditions after harvesting to the germination of grain and seeds; study of methods of making germination tests to attain greater accuracy; study of the hard seeds of legumes to determine their value and to find methods of treatment that will increase their germination; cooperative study with laboratories in other states to improve laboratory technique.

SOIL SURVEYS

In 1921 a cooperative arrangement was entered into between the Montana Agricultural Experiment Station and the Bureau of Chemistry and Soils of the United States Department of Agriculture which made possible a reconnoissance of the soils of the state. The bureau agreed to provide one field man and pay his expenses while in the field. The station also provided a field man who, during the winter season, prepares the maps and the results of the field work for publication.

In 1925 the state legislature made a small appropriation for additional soil studies so that it was possible to undertake detailed surveys on some of the irrigation projects. Again cooperative arrangements with the Bureau of Chemistry and Soils were made and the salary of a field man and his expenses were provided. The bureau will print regional descriptions and colored maps of both the reconnoissance and the detailed survey reports.

Soil surveys in Montana. Cooperative with the United States Department of Agriculture.

(a) A reconnoissance survey to cover all the lands of the state. Up to the present time twenty counties have been surveyed, or about one-third of the state.

(b) A detailed soil survey. The irrigated areas of the state are first being surveyed. To date the following projects have been covered: Valier, Sun River, Fort Shaw, Milk River, Lower Flathead River, Gallatin Valley, and Lower Yellowstone River.

HORTICULTURAL BRANCH STATION

The Horticultural Branch Station, near Corvallis in the Bitter Root Valley, was established by the state legislature in 1907. Twenty acres of land were donated by the people of the valley and ten additional acres were later purchased by the state. The land is all under irrigation. Two cottages, a horse barn with space for storage of implements, and two other buildings have been erected by the state.

This branch station was established to study the fruit, vegetable, and other problems of the fruit-growing areas of the western part of the state. Sufficient funds have never been provided to permit giving the service needed, but the station has been a valuable center for the study of the fruit and vegetable problems of this region as carried on by the various departments of the main station at Bozeman.

The special projects being studied are as follows:

Cultural tests with cover crops for the apple orchard.

Value of various commercial fertilizers for improving yield and quality of tree fruits.

Tests of standard and new varieties of apple, cherry, and plum.

Variety and cultural tests of small fruits and their adaptation to western Montana.

Ornamental trees and shrubs and the best methods of growing them under conditions in western Montana.

Kinds and varieties of vegetables and the cultural practices most suitable for western Montana.

Problems of cherry production in western Montana.

Factors influencing potato production in western Montana.

JUDITH BASIN BRANCH STATION

The Judith Basin Branch Station was established by the state legislature of 1907. It is located at Moccasin, near the center of the Judith Basin. The late S. S. Hobson, of Lewistown, donated 160 acres of land and provided funds for the erection of certain buildings. The experimental work was started in 1908. As funds were limited

the Bureau of Plant Industry, United States Department of Agriculture, was persuaded to cooperate and agreed to pay the salary of the superintendent.

As the years passed and the work was enlarged the bureau paid the salaries of two other members of the staff employed at this station. With the development of the work and local requests for livestock studies, additional land was rented from the state, making now an area of 600 acres for the station work. The state has also provided funds for the erection of several buildings.

The station is located at an elevation of about 4,300 feet. The work is confined solely to dry farming studies with different kinds of grain, with forage crops, crop rotation, shelterbelts, dairy cows, hogs, etc. It is well equipped for carrying on the studies undertaken. The results are applicable to the dry-farm areas in the higher valleys of the state.

Meteorological observations are made throughout the year on precipitation, evaporation, temperature (maximum and minimum), and wind velocity.

The following projects are under way at the present time:

Dry-land crop rotations—the effect of different crop sequences and various methods of cultivation and fertilization on the yield of crops and the maintenance of yield. The crops used are winter and spring wheat, oats, barley, rye, flax, corn as a fodder, alfalfa, clover, grasses, potatoes, etc. Some 162 plots one-tenth acre in area are used.

Tests of standard grain varieties under field conditions with different methods of soil preparation.

Increase of foundation seed stocks to maintain and improve the seed grains used in the state.

Tests of bean varieties adapted to dry-farming conditions in central Montana.

Commercial mustard production on the dry-land farm.

Potatoes in a dry-land rotation—methods of cultivation and crop sequence that will give maximum returns.

The vegetable garden—kinds and varieties of vegetables and methods of growing under dry-farm conditions.

Varieties of sweet corn adapted to the dry farm in central Montana.

Varieties of apples, plums, and small fruits and their adaptability to dry-land conditions in the higher valleys of the state.

Shelterbelt investigations with deciduous trees—kinds of trees and shrubs; methods of planting, cultivation, and care on dry land.

Species of conifers and methods of planting and caring for them on the dry farm.

Methods of handling and spacing evergreens in connection with caragana in starting shelterbelts.

Cereal crop investigations

Winter wheat varietal tests—21 varieties on 84 one-fiftieth-acre plots are tested for yield, winter hardiness, and quality.

Rate and date of seeding winter wheat, with comparative results from seeding with the furrow drill and with the ordinary grain drill.

Winter wheat nursery.

(a) Testing of about 55 hybrid wheats in 8-rod rows.

(b) Study of 306 varieties and strains of winter wheat in rod rows, to compare yield, winter hardiness, protein content, smut resistance, etc.

Spring wheat varietal tests—22 varieties on 88 one-fiftieth-acre plots are used in studying yield, quality, rust resistance, etc.

Rate and date of seeding spring wheat, using standard varieties.

Spring wheat nursery—150 varieties grown in rod rows to determine comparative yield, protein content, and smut resistance.

Milling and baking studies with winter wheats and spring wheats.

Oat varietal tests with 11 varieties on 44 one-fiftieth-acre plots, to compare yield, quality, season of maturity, etc.

Effect of rate and date of seeding oats on their yield.

Oat nursery—140 varieties and strains grown in rod rows to compare yield and other characteristics.

Barley varietal tests with 11 varieties on 43 one-fiftieth-acre plots, to compare yield, quality, etc.

Effect of rate and date of seeding barley on yield, etc.

Barley nursery—yield and other characteristics of 305 varieties grown in 20-foot rows.

Flax varietal tests with 10 varieties on 30 one-fiftieth-acre plots to determine yield and adaptability to the higher valleys of the state.

FORAGE CROP STUDIES

Alfalfa varieties—forage and seed yield and relative hardiness under Montana dry-land conditions, 24 varieties being tested.

Effect of renovation and different methods of cultivation and fertilization on yield and stand of alfalfa.

Alfalfa in cultivated rows compared with close-drilled for hay and seed production.

Comparison of planting alfalfa alone with planting a mixture of alfalfa and crested wheat grass as to hay yield on dry land.

Study of the forage and seed yields of varieties and strains of sweet clover.

Comparison of the yields of sweet clover with different rates and methods of seeding.

Study in the nursery row of varieties and strains of sweet clover and their adaptability to dry-farm conditions in central Montana.

Comparison of seeding sweet clover alone or seeding with wheat and other cereals.

Comparison of yields from sweet clover-grass mixtures with different rates and methods of seeding.

Autumn plantings on dry land of alfalfa, grass, and sweet clover to determine the possibility of securing good stands.

Tests of domestic and imported grasses for forage and seed yields under dry-land conditions. Three varieties and 205 plots are used in these tests.

Grasses in the nursery row—their hardiness and other characteristics. Selections and hybrids of domestic and imported grasses. Securing stands of crested wheat grass on abandoned wheat land.

Comparison of yield of cereal grasses and legumes from clippings made throughout the summer. Yields of clippings indicate the expected value of these crops for pasture.

Comparative yields of forage from millet, sorgo, sudan grass, corn, and oats under dry-land conditions in central Montana.

Fodder yields of different varieties and strains of corn and their adaptability to the dry-land farm.

Comparison of hay yields of small grains and peas alone on dry land.

The relative yield of hay from oats and barley planted at different dates.

The value for dairy cows of pasture on the dry land seeded to brome grass, crested wheat grass, sweet clover, and mixtures of these, with various methods of handling, fertilizing, etc.

The carrying capacity of sweet clover and alfalfa pasture on dry land for hogs fed a carrying grain ration.

LIVESTOCK STUDIES

The value of dual-purpose Shorthorn cattle on the dry farm.

Pork production on the dry farm.

NORTHERN MONTANA BRANCH STATION

The Northern Montana Branch Experiment Station was established by the state legislature in 1913. Five thousand dollars was appropriated to purchase 2,000 acres of land, including the old buildings of Fort Assinniboine, near Havre. In opening the reservation for settlement in February, 1915, the Congress provided that the state should have the privilege of purchasing the 2,000 acres of land and the buildings thereon for $5,000, and this amount was paid to the United States Government as soon as the reservation was opened. The purpose of this station was to study the crop and livestock problems of the northern areas of the state under climatic and soil conditions peculiar to that region. All tests are on non-irrigated land.

Work at the station was started in 1915 but it was not in full operation until 1916. The appropriation from the state was small and so the amount made available for the two years was used largely in one. The Bureau of Plant Industry, United States Department of Agriculture, through its dry-farming office, was interested in the station and paid the salary of the superintendent and contributed somewhat to other expenses. As the work developed studies were undertaken with cereals and forage crops and the United States Department of Agriculture increased its contribution to aid in these studies. At this, as at all branch stations, meteorological observations have been recorded through the years, giving maximum and minimum temperatures, the rainfall, evaporation, wind velocity, etc., so that these factors can be correlated with the growth and yield of the crops. Much of the area making up the station farm was selected as suitable for livestock studies, and a few years after the station was established thirty head of high grade Hereford heifers were purchased. These have now grown to a herd of over 150 head

of all ages. Hogs and sheep were added still later but with reduced incomes the sheep have been disposed of. The Bureau of Animal Industry, United States Department of Agriculture, has aided in the livestock studies by contributing toward the pay of the man in charge.

No new buildings have been erected, but some of the old Fort buildings have been repaired and remodeled to serve the purposes of the station work. The buildings not used by the station have been wrecked and removed by the state. Much cleaning up of the grounds yet remains to be done but this task must await special funds to be provided by the state. The following projects are in progress at this station:

Crop rotations

Rotations of two to six years' duration with winter wheat, spring wheat, oats, barley, corn, winter rye, flax, peas, alfalfa, sweet clover, and brome grass.

Green manure rotations with rye, sweet clover, and peas compared with ordinary fallow and manured fallow.

Relation of tillage methods to crop yields.

Relation of the preceding crop and tillage methods to moisture conservation.

Yields under continuous cropping with various methods of cultivation.

Forage crop rotations with grain, hay, peas, corn, sudan grass, millet, etc.

Comparison of potatoes and sugar beets when grown continuously, after fallow, or after a grain crop.

Variety and other tests with grains

Cooperative tests of winter wheat varieties for yield, quality, hardiness, etc.—15 varieties and 45 one-fiftieth-acre plots, grown on dry land.

Winter hardiness nursery to determine the resistance of a large number of varieties and strains of winter wheat to the extremes of the winter season.

Comparative tests of spring wheat varieties to determine yield, quality, and other desirable factors on dry land—22 varieties on 66 one-fiftieth-acre plots.

Spring wheat experiments to develop and select varieties with larger yields of better quality and better adapted to Montana

markets. Some 200 varieties, selections, and hybrid selections are in the test, largely in triplicated rows.

A study of the nitrogen in the soil as affecting the protein content of spring wheat.

Note: Study of the protein content of each and all the varieties and strains of spring and winter wheat is an important factor in the comparisons of varieties of winter and spring wheat. Some 150 protein determinations have been made.

Milling and baking studies with winter wheats and spring wheats.

Effect of different methods and times of cultivating fallow on yields of Marquis wheat.

Effect of different methods of spring cultivation of fallow and subsequent delay in seeding upon the control of weeds and the yield of barley, wheat, etc.

The use of the furrow drill as contrasted with the ordinary drill in controlling winter killing.

Studies on varieties of oats adapted to dry land in northern Montana to determine yield and other qualities—18 varieties on 54 one-fiftieth-acre plots.

Oat-breeding experiments, with cooperative studies in the oat nursery to develop pure line selection and strains of early, mid-season, and late varieties adapted to northern Montana. Some 65 varieties and selections in triplicated single rod rows.

Effect of date of seeding on yield and certain quality factors, using early, medium, and late varieties, considering the amount and dependability of their yield.

A comparison of winter rye and spring rye as to yields of grain and forage on the dry land.

Varieties of barley tested as to their yield and quality for use on northern Montana dry farms—14 varieties on 42 one-fiftieth-acre plots.

Barley-breeding experiments to develop from introductions, selections, and hybridization the varieties better adapted to the dry lands of northern Montana—105 varieties and selections were sown in these experiments.

Study of varieties and strains of corn to determine value for production of grain and forage—14 varieties, etc., on 42 plots.

Breeding experiments with corn to develop by inbreeding and subsequent crossing of the inbred lines, higher yields of corn for

northern Montana and to investigate the genetic principles involved. About 250 inbred lines and numerous crosses were made this year.

The effect of changes in dates of seeding Northwestern Dent corn on yields of grain and fodder on the dry farm.

Flax varieties, their yields and adaptability to northern Montana —9 varieties on 27 one-thirtieth-acre plots.

Varieties of field beans adapted to northern Montana, based on yield and dependability of the crop—14 varieties in triplicated rows 90 feet long.

Forage crop studies

Alfalfa varieties—the yield, hardiness, and other qualities that would adapt them to the dry lands of northern Montana; 10 varieties; also numerous selections of Ladak, involving wilt-resistant investigations, studies dealing with vegetative type, etc.

Comparison of yields of alfalfa planted in rows 2, 3, 4, and 5 feet apart with alfalfa close drilled.

Varieties of sweet clover—their relative values for northern Montana.

A comparison of yellow and white sweet clover seeded in close-drilled rows and in rows 36 inches apart, with special reference to yields and quality of forage.

Effect of a nurse crop of grains on the stand of sweet clover seeded at different dates with and without a nurse crop.

Comparative yields of hay grain from oats, wheat, barley, and spring rye.

Comparison of yields of hay from oats and millet when seeded at different dates.

The effect of date and method of seeding on stand and yield of brome grass, slender wheat grass, and crested wheat grass when close drilled and when seeded 36 inches apart.

Comparative yields of Dakota amber sorgo, sudan grass, and corn, when planted at different dates.

Comparison of the yields of different varieties of mangels, carrots, turnips, rutabagas, and sugar beets.

Renovating native sod by the application of barnyard manure and different methods of cultivation.

Comparative yield of corn and sunflowers as silage crops for the dry land.

Comparative value of forage from corn and sunflowers and also their value as substitutes for fallow as determined by yields of small grain following them.

LIVESTOCK FEEDING AND BREEDING TESTS

Beef cows

(a) Tests of different kinds of roughage for wintering cows, including alfalfa, sweet clover, blue joint, oat hay, and corn fodder.

(b) Effect of winter rations and levels of feeding during winter months upon summer gains and upon weights of calves produced.

(c) Factors influencing costs of maintenance.

Growing heifers.

(a) To determine the effect of different levels of winter feeding upon the weights of growing calves, yearlings and two-year-olds at the end of winter feeding periods, weights the following summer, weights of the cows at maturity, and weights of the calves produced at maturity.

(b) To determine relative costs of wintering in relation to productive capacity of cows produced.

Relation of large type and small type bulls to production in range beef cattle.

A comparison of full-feeding calves grain and alfalfa for a six-month period with feeding calves a limited amount of grain during the winter followed by full-feeding grain on grass during the summer and full-feeding grain and alfalfa in a dry lot the last 90 days of a twelve-month period.

Fattening pigs with grain grown in northern Montana, including wheat, rye, and barley, when supplemented with alfalfa and tankage.

THE HUNTLEY FIELD STATION

This station, near Huntley, was started in 1911 and is owned and operated by the United States Department of Agriculture. The following divisions of the department are cooperating at the station: Western Irrigation Agriculture, Dry Land Agriculture, and the Bureau of Dairy Industry. The Montana Agricultural Experiment Station is cooperating in carrying on this work.

The station was organized to study the problems of the new irrigation districts along the Yellowstone River in the plains area of Montana. This area has a longer growing season than the higher areas and the mountain valleys of the state and therefore produces a greater variety of crops.

Irrigated crop rotations, started in 1916

Fifteen plots continuously cropped to 8 different crops which are manured and managed in various ways.

Eleven 2-year rotations, comparing different crops and methods of cultivation and fertilizing.

Six 3-year rotations.

Six 4-year rotations, four of these with 2 years in alfalfa.

Five 6-year rotations, all with 3 years in alfalfa.

Maximum crop rotation test to show possibilities of yield from different crops under irrigation.

The crops in the rotations are sugar beets, beans, wheat, 5 years of alfalfa, corn, potatoes, and oats. The beets, beans, corn, potatoes, and 2 years of the alfalfa are manured. Tests of selections of Great Northern beans to determine yield and resistance to disease. Tests of commercial fertilizers for the best crop. Tests of 5 standard varieties of alfalfa to determine that best adapted to this region of the state. Tests of 13 varieties of wheat under irrigation. Experiments with corn as a silage crop. Fattening range lambs with various grains and roughages, particularly to measure the comparative value of sugar beet pulp, tops, and molasses.

Field experiments on non-irrigated land

Crop rotations and tillage methods with cereals and forage crops.

Variety tests with winter wheat, spring wheat, oats, barley, flax, corn, potatoes, and beans.

Tests of forage crops, including varieties of alfalfa, sorgo, sudan grass, and soy beans.

Pasture grass experiments with annual and perennial crops in feeding pigs.

Tests of garden crops and varieties adapted to dry land.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

The Fort Keogh military reservation of nearly 70,000 acres of land near Miles City, was transferred to the United States Department of Agriculture in 1924. The Range Livestock Experiment Station

was established by the Bureau of Animal Industry of the department that same year, to study the range problems of Wyoming, North Dakota, South Dakota, and Montana. These three states adjoin Montana on the south and east. Most of the land is a rolling range pasture, but a few thousand acres on the bottom lands to the south of Yellowstone River are farmed. The larger portion of this farm area is irrigated, the water being obtained from Yellowstone River by a pumping plant. The station buildings are about two miles west of Miles City. Through a cooperative arrangement with the Bureau of Animal Industry, the Montana Experiment Station gets full reports on the studies carried on at this station. The work covered is described below:

Draft horse production

(a) The study of pure-bred draft sires mated with grade and pure-bred draft mares.

(b) Methods of feeding and management of the breeding animals, both summer and winter, to maintain weight and vigor.

(c) Cost of raising and developing draft horses, including feed, labor, etc. Records will also be kept of the feed of the mature horses used on the farm.

Light horse production

(a) Results of pure-bred saddle-type sires bred to western grade and pure-bred mares of saddle type.

(b) Methods of feeding and management to produce and develop high-class saddle horses.

(c) Amount and cost of feed and labor necessary to care for the mares and to raise the young stock.

(d) Records will be kept of the use of saddle horses on the farm, including feed, management, and effect of development.

Beef cattle investigations

Range utilization—grazing and vegetation studies, and determination of carrying capacity of short grass ranges.

(a) Carrying capacity under summer and winter range conditions with breeding cows and two-year-old heifers.

(b) Regulation of cattle ranges to secure normal development and optimum use.

Breeding beef cattle—to establish breeding strains of Hereford cattle, adapted to western range country, good breeders of desirable type and conformation and capacity for economical and rapid gains.

Cattle feeding—the most practical feeds and methods of wintering beef cattle under Great Plains conditions.

(a) The value of supplemental feeds on the range and in the feed lots in wintering breeding cows.

(b) The value of various concentrates and roughages in wintering heifer calves and yearling heifers for replacement in the breeding herd.

(c) Growing beef steers of different ages with various winter rations and on different planes of nutrition to determine the gains and cost for the various ages. High, medium, and low plane rations are being compared.

(d) Fattening beef cattle of various ages on various Montana grains and forages to determine the rate and cost of gains and the quality of the meat produced.

RANGE SHEEP INVESTIGATIONS

The use of the range by sheep and the effect on the vegetation from different methods of management.

(a) The value of various concentrates and roughages for breeding ewes and lambs on the range and in the feed lots.

(b) Fattening feeder lambs to determine relative returns compared with selling lambs as feeders, and to measure the value of various concentrates and roughages as fattening feeds.

STUDIES IN WOOL PRODUCTION

(a) The factors affecting the growth and yield of wool as influenced by various methods of feeding and management.

(b) Factors influencing the improvement of wool as to uniformity, quality, length of staple, character, etc.

LAMB PRODUCTION ON THE RANGE

(a) The influence of type, conformation, and age of breeding ewes and rams on the production and value of lambs.

SWINE INVESTIGATIONS

(a) The needs and methods of management for growing and maintaining breeding stock and also the market hogs.

(b) A comparison of mature sows and gilts as breeding stock in producing market hogs.

(c) To compare the relative economy of producing the bacon and the lard types of hogs and to determine the most economical and practical type of hogs for producing Wiltshire sides, bacon and other cuts of pork for domestic use.

(d) To determine the most economical method of handling and feeding hogs during different periods of growth and to study problems concerning sanitary conditions and hog-lot equipment.

INVESTIGATIONS WITH TURKEYS

Problems pertaining to the raising, feeding, management, and marketing of turkeys in the northern Great Plains region.

THE STATION STAFF

There were no changes in the station staff during the year 1932. Mr. A. H. Post, associate professor of agronomy, who was on leave of absence, returned, and Mr. E. A. Starch, associate professor of agricultural economics, was granted leave for graduate study.

BUILDINGS AND EQUIPMENT

No major improvements were undertaken during the year but some additions have been made to the laboratory equipment of various departments.

COOPERATION WITH OTHER AGENCIES

The cordial cooperative arrangements for research work with various state and federal agencies which have been going forward for several years have been continued during 1932. Especial mention should be made of the support given by the Montana Livestock Sanitary Board to the Veterinary Research Laboratory and that by the Anaconda Copper Mining Company to fertilizer studies over the state. The support of the United States Department of Agriculture to the branch station near Havre, in northern Montana, and to the Judith Basin Branch Station, near Moccasin, has continued, as has also the contribution to the soil surveys. During the year the report on the survey of the Milk River irrigation project has been published by the United States Department of Agriculture. This report contains two colored maps, showing the different soils on this project.

PUBLICATIONS

The publications of the Experiment Station for the past year included fifteen bulletins, one circular, and sixteen technical papers.

The bulletins and circulars were printed in editions ranging from 2,000 to 7,000 copies, and with the annual report, make a volume of 617 pages.

The bulletins are designed to report the results of the experiments carried on by the station staff. Many of the more technical reports are published in scientific journals.

Since the last annual report the following publications have been issued:

BULLETINS

No. 255. Seepage and Drainage of Irrigated Land. H. E. Murdock. 2,000 copies, 32 pages.

No. 256. Pollination of the McIntosh Apple. F. M. Harrington and W. E. Pollinger. 3,000 copies, 12 pages.

No. 257. The Use of Tankage and Alfalfa When Hogging Down Corn. Louis Vinke and George Morgan. 3,000 copies, 19 pages.

No. 258. The Economics of Bean Production and Marketing in Montana. R. R. Renne. 4,000 copies, 47 pages.

No. 259. A Progress Report on the Phosphate Deficiency of Montana Soils. Iver J. Nygard. 6,000 copies, 27 pages.

No. 260. The Quality of Living in Montana Farm Homes. Jessie E. Richardson. 4,000 copies, 64 pages.

No. 261. Annual Forage Crops Under Irrigation. J. E. Norton. 3,000 copies, 17 pages.

No. 262. Rural Contributions to Urban Leadership in Montana. Elmo H. Lott. 2,500 copies, 44 pages.

No. 263. Potatoes in Irrigated Rotations. D. A. Savage. 3,000 copies, 36 pages.

No. 264. Organization, Feeding Methods and Other Practices Affecting Returns on Irrigated Dairy Farms in Western Montana. Sherman E. Johnson, J. O. Tretsven, Mordecai Ezekiel and O. V. Wells. 2,000 copies, 73 pages.

No. 265. Organization of the Range Cattle Business in Eastern Montana. Robert S. Fletcher. 3,000 copies, 63 pages.

No. 266. Oat and Barley Varieties Under Irrigation. J. E. Norton and LeRoy Powers. 3,000 copies, 27 pages.

No. 267. The Correlation Between the Organisms Found Microscopically and the Bacteriological Deterioration of Butter. J. A. Nelson. 3,000 copies, 27 pages.

No. 268. The Rocky Mountain Wood Tick. R. A. Cooley. 7,000 copies, 58 pages.

No. 269. Montana Insect Pests for 1931 and 1932. A. L. Strand. 3,500 copies, 28 pages.

CIRCULAR

No. 139. Method and Purpose of a Soil Survey. William DeYoung. 7,000 copies, 11 pages.

ANNUAL REPORT

Agricultural Experiment Station: Thirty-Ninth Annual Report. F. B. Linfield. 5,000 copies, 32 pages.

TECHNICAL PAPERS

Ether-soluble constituents of wheat flour. W. McK. Martin and W. O. Whitcomb. Cereal Chemistry 9:275. May, 1932.

A modification of the rapid agglutination test for Pullorum disease. Howard Welch. Jour. Am. Vet. Med. Assn. 80:778. May, 1932.

Chemical and physical properties of petroleum spray oils. Jesse Green and W. McK. Martin. Jour. Agr. Research 44:773. May. 15, 1932.

Bacterial flora of the intestinal tube of normal young lambs. E. A. Tunnicliff. Jour. Am. Vet. Med. Assn. 80:615. April, 1932.

p_H and wireworm incidence. G. Allen Mail. Jour. Economic Entomology 25:836. August, 1932.

A study of the tuberculin sensitization in cattle showing subcutaneous lesions. H. Marsh, D. M. Warren, A. C. Morrow. Jour. Am. Vet. Med. Assn. 81:105. July, 1932.

A study of clostridium welchii types encountered in lamb dysentery investigations. H. Marsh, E. A. Tunnicliff, Erwin Jungherr. Jour. Infectious Diseases 51:330. Sept.-Oct-, 1932.

Chlorosis of trees. Edmund Burke. Plant Physiology 7:329. 1932.

Mastitis in ewes, caused by infection with a pasteurella. H. Marsh. Jour. Am. Vet. Med. Assn. 81:376. Sept., 1932.

Observations on an undirectional flight of army cutworm moths and their possible bearing on aestivation. J. H. Pepper. Canadian Entomologist 64:241. Nov. 1932.

Catalase activity in army cutworm moths (Chorizagrotis auxiliaris Grote). J. H. Pepper. Jour. Economic Entomology 25:1128. Dec., 1932.

Availability of vitamins in plant tissues. Jessie E. Richardson and Helen L. Mayfield. Science 76:498. Nov. 25, 1932.

Winter temperature gradients as a factor in insect survival. G. Allen Mail. Jour. Economic Entomology. 25:1049. Oct., 1932.

Some remarks on the physiological action of oil sprays. A. L. Strand. Jour. Economic Entomology 25:991. Oct., 1932.

Prediction of pale western cutworm increase in Montana is fulfilled. R. E. Wall. Jour. Economic Entomology 25:1043. Oct., 1932.

An attempt to separate from petroleum spray oils the portion which is injurious to plants. Jesse R. Green. Oil and Gas Journal, Feb. 2, 1932.

METEOROLOGICAL REPORT FOR 1932

The following meteorological records are kept—maximum and minimum temperatures, wet and dry bulb thermometer readings, evaporation from a water surface, wind velocity, wind direction, hours of sunshine, and inches of rainfall. These records are taken every day. The station is well equipped with meteorological instruments.

The precipitation during the year at Bozeman was below normal, but good. Rains in the spring and summer were favorable to crop growth. The mean temperature was above normal for the year and the wind velocity was high during the spring months. The summary of the weather record by months and the summary for the year are given in the following tables.

METEOROLOGICAL SUMMARY FOR 1932
BOZEMAN

Highest temperature	93°, July 17
Lowest temperature	-35°, December 9
Greatest range for year	128°
Highest monthly mean	66°, July
Lowest monthly mean	14.3°, December
Highest daily mean	76.5°, August 17
Lowest daily mean	-26°, December 9
Mean temperature for year	41.5°
Greatest total precipitation for one month	3.29 inches, June
Least total precipitation for one month	0.21 inch, September
Total rainfall	17.34 inches
First killing frost	October 4
Last killing frost	May 1
Number of clear days in year	107
Number of partly cloudy days in year	162
Number of cloudy days in year	97
Days with 0.01 inch or more precipitation	117
Total evaporation from May to October, inclusive*	37.42 inches

*Can not be compared with other years as April is missing.

FINANCIAL SUMMARY

EXPENDITURES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1932

	Hatch Fund	Adams Fund	Purnell Fund	State Appropriations and Miscellaneous*
By salaries	$10,164.75	$12,425.72	$36,825.20	$ 62,859.02
Labor	1,612.48	980.64	12,234.36	26,497.03
Supplies and materials	1,589.02	628.44	1,823.25	15,651.56
Communication service	72.31	3.25	52.62	1,236.87
Travel expense	581.53	712.18	5,636.87	1,041.88
Transportation of things	16.45	12.38	165.82	371.99
Publications	—	—	752.05	2,108.54
Heat, light, water and power	2.13	—	123.00	4,057.55
Contingent expense	1.68	—	—	30.00
Equipment	959.65	237.39	2,386.83	5,105.41
Buildings and land	—	—	—	7,367.99
Unexpended balance	—	—	—	6,697.98
Total	$15,000.00	$15,000.00	$60,000.00	$133,025.82

*This fund includes the following:

State appropriations for Home Station	$69,883.74
For Grain Laboratory and Branch Stations	41,620.48
Income from sales	21,521.60